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Comment on Estimation and Interpretation of Empirical Studies in Industrial Economics

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Comment on Estimation and Interpretation of Empirical Studies in Industrial Economics

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Abstract

After reporting a transcription error concerning the sign of a critical coefficient estimate in Connor and Peterson (1992), their data set is used to illustrate the appropriate interpretation of regression results when interactive terms enter as explanatory variables.

1. INTRODUCTION

Connor and Peterson (1992) use an ingeniously constructed dependent variable to analyze structural and behavioral characteristics that explain differences in price between competing national and private label brands of manufactured food products.

In the course of research on the robustness of empirical results in industrial economics to the use of techniques that control for the presence of outliers[1] it became apparent to one of the authors of this note that a transcription error had resulted in the reporting of an incorrect sign for a critical coefficient estimate in Connor and Peterson (1992): the coefficient of the linear concentration variable in Table 1 of Connor and Peterson is negative, not positive.

In this note, we discuss the results yielded by applying estimation techniques that allow for the possibility of data imperfections to the Connor and Peterson data set. We also discuss the interpretation of regression results obtained using nonlinear specifications and suggest that from this point of view the work of Connor and Peterson can be viewed as taking up a line of research suggested by Weiss (1971).

2. ROBUST ESTIMATION

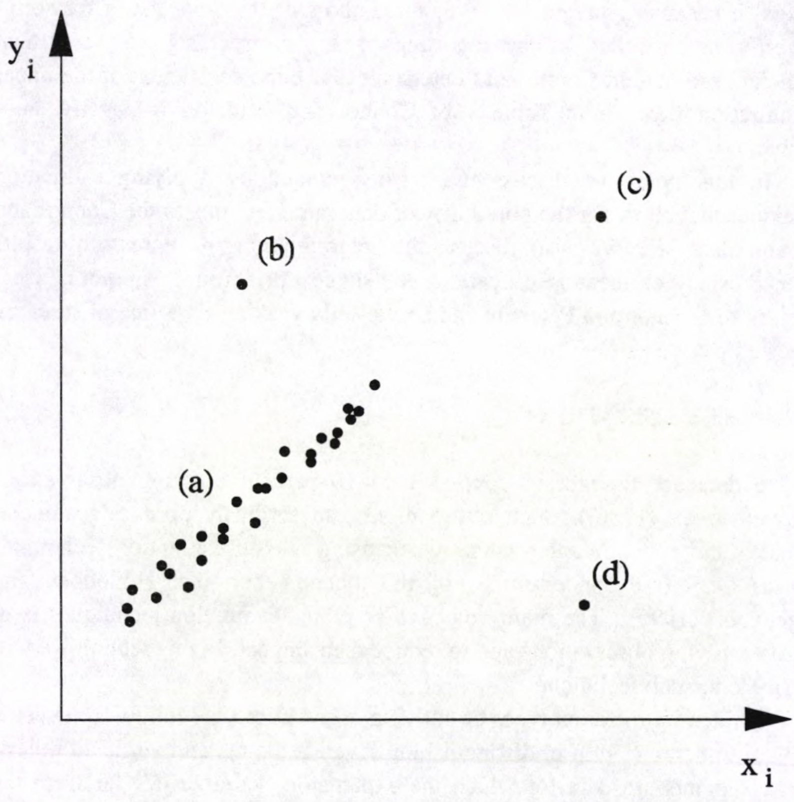
Routine data are thought to contain 1 to 10 percent outlying observations (Hampel et. al. (1986)). Such observations can seriously obscure parameter estimates and concomitant t-values when using classic estimation techniques such as OLS (see for examples of this phenomenon e.g. Hinloopen and Wagenvoort (1995)). The main objective of robust estimation techniques is to identify outlying observations and to reduce their impact. In this section we will describe one such technique.[2]

To identify different types of outlying observations we follow Rousseeuw and van Zomeren (1990) in distinguishing leverage points and vertical outliers. Leverage points are data for which the explanatory variable lies far from the

[1] As part of a Ph.D. dissertation to be submitted to the Department of Economics, European University Institute. In this regard, we would like to express our thanks to Professors Connor and Peterson for making available their data set.

[2] For an excellent survey on robust estimation see Huber (1981).

Figure 1 Simple Regression Example with (a) Regular Observations, (b) Vertical Outlier, (c) Good Leverage Point, and (d) Leverage Point and Vertical Outlier (Bad Leverage Point)



Source: Rousseeuw and Van Zomeren (1990) bulk of explanatory observations (according to some measure of distance). Vertical outliers are observations which are positioned far from the majority of the data, but whose explanatory variable is not necessarily a leverage point. An observation can be both a leverage point and a vertical outlier (see Figure 1). Observe that observations which are only leverage points are in concordance with the statistical relation exhibited by the majority of the data (Rousseeuw and Van Zomeren call these good leverage points), whereas vertically outlying observations do not match the main statistical relation, whether they are leverage points or not. It is the latter type of outlying observations we seek to identify and control for when estimating.

In order to determine which observations are vertically outlying a preliminary estimate needs to be generated which is not influenced by data contamination. For this purpose we use Rousseew's Least Median of Squares (LMS) estimator (see Rousseeuw (1984) and Rousseeuw and Leroy (1987)) because it is relatively easy to compute and because it has a breakdown point of 50%.[3] Observations which have a standardized error of more than 2.57[4] in absolute value with respect to the fitted LMS line are treated as vertical outliers. These observations are removed from the sample and OLS estimates are computed using the resulting data set.

3. NONLINEAR SPECIFICATION

Connor and Peterson use a specification that is linear in the coefficients to be estimated but interactive in some of the explanatory variables. In addition to including the basic Lerner index expression H/E_d as a right-hand side variable, they include the products of the Herfindahl index and three other variables as explanatory variables. These interactive terms are intended to control for the impact of trade flows, regional markets, and the share of consumers in total demand (Connor and Peterson, 1992, pp.160-161).

We would make two points regarding such a specification. The first is theoretical. An interactive specification may be justified from first principles, as

[3] An estimator's breakdown point is defined as the minimum fraction of data contamination that causes it to take on any value (see Donoho and Huber (1983)). A breakdown point of 50% is the maximum possible, since beyond this limit the distinction between good data and bad data becomes arbitrary. The breakdown point of OLS is 0%: one outlying observation can cause OLS to produce any estimate.

[4] This is the 99% critical value of the standard normal distribution for two-tailed tests.

well as for reasons of data definition (Weiss, 1971, pp.375-8). Market concentration may be thought of as a necessary but not sufficient condition for the exercise of market power by some firms. If a market is unconcentrated, rivalry among incumbents should yield results that approximate those expected from workable competition. If a market is concentrated *and* some firms enjoy product differentiation advantages *and* entry costs are great enough so that the force of potential competition is weak, *then* some or all firms in the market may enjoy economic profit.[5]

The second point regards interpretation. Suppose for simplicity that market concentration is interacted with a single variable, so that one estimates the equation[6]

$$PCM = \alpha + \beta \frac{H}{E_d} + \gamma H y + \varepsilon, \tag{3.1}$$

where α, β and γ are parameters to be estimated, H is the Herfindahl index, E_d the price elasticity of demand, y the conditioning variable, and ε an error term. To evaluate the concentration-profitability relationship, the statistic of interest is

$$\frac{\partial PCM}{\partial H} = \frac{\beta}{H_d} + \gamma y, \tag{3.2}$$

an estimate of which will differ in magnitude, potentially in sign, and in statistical significance at every point in the sample. It is incomplete to emphasize the coefficient of the linear term alone as characterizing the nature of the concentration-price-cost margin relationship.[7]

---

[5] In this spirit, we have estimated a respecified version of the Connor-Peterson equation that interacts H with *ADBFS*. We do not report these estimates here, to maintain comparability with the Connor-Peterson results, but tables reporting these results (including all observations and with vertical outliers eliminated) are available on request.

[6] The extension to the case in which the model is not linear in the coefficients to be estimated follows from Goldberger (1964, p.124). For another example of a paper which uses an interactive specification but does not report estimates of the estimated profitability-concentration derivative, see Amato and Wilder (1995).

[7] For a paper that examines the values of estimated partial derivatives at different points in the sample space, see Koo and Martin (1984).

4. EMPIRICAL RESULTS

Table 4.1 reports weighted-least squares regressions, using samples restricted by removal of vertical outliers, which correspond to Table 1 of Conner and Peterson (1992).[8] The coefficient of the linear concentration term remains significantly negative, as in the Connor and Peterson study. The negative estimated coefficient in the linear concentration term does not appear to reflect the presence of vertical outliers.

Focusing for concreteness on the first column of Table 4.1, we have

$$\frac{\partial PCM79}{\partial H} = -\frac{1.358}{E_d} - 0.557\,GEOG + 0.489\,FS, \tag{4.1}$$

where *GEOG* varies between 28.9 and 115.1 in the sample with vertical outliers removed and higher values indicate that the market is more nearly national, and *FS* varies between 0 and 100% and higher values indicate that more of the product is sold to food stores.[9]

If equation (4.1) is evaluated at the sample mean, the result is $\partial PCM79/\partial H = -1.048$, with a (heteroskedasticity-consistent) *t*-statistic of 0.1578. At the sample mean the negative coefficient of H/E_d dominates and the estimated effect of an increase in concentration, although not statistically significant, is to reduce national brands' price-cost margin.

It is useful, however, to examine equation (4.1) and to ask what combinations of *GEOG*, *FS* and E_d will yield a particular sign for $\partial PCM79/\partial H$. From

$$\frac{\partial PCM79}{\partial H} = -\frac{1.358}{E_d} - 0.557\,GEOG + 0.489\,FS > 0 \tag{4.2}$$

---

[8] We have replicated the regressions Connor and Peterson report in their Table 1; the results are identical except that the estimated coefficients of H/E_d are negative, not positive.

[9] Connor and Peterson (1992, pp.160-1) expect a negative coefficient for $H*FS$. An alternative argument would be that the greater the share of industry shipments made to food stores, the greater the potential for product differentiation in the eyes of the final consumer. In the event, they estimate positive coefficients for $H*FS$, as do we. The statement that *FS* is bounded above by 100% is based on the discussion of Connor and Peterson (1992, p.100). Values exceeding 100% appear to occur for some observations, however.

Table 4.1 Regression Results Explaining National Brand-Private Label Price Differences Among Manufactured Food Products; Vertical Outliers Removed[a]

	Dependent Variable		
	PCM79	PCM80	PCM7980
C	-6.243 (1.58)	5.811 (4.78)	4.910 (6.52)
H/E_d	-1.358 (3.62)	-1.641 (5.32)	-1.331 (4.13)
ADBFS	3.164 (10.03)	2.892 (8.68)	3.373 (19.94)
TVAD	0.040 (1.15)	0.177 (4.78)	0.087 (3.59)
H*IMP		-0.722 (3.82)	-0.643 (6.15)
H*GEOG	-0.557 (3.39)	-0.595 (4.29)	-0.588 (5.49)
H*FS	0.490 (5.84)	0.238 (3.25)	0.367 (5.45)
GRO7782	0.087 (3.07)		
$\bar{R}^2$	0.77	0.72	0.90
No.Observations (No. Outliers)	36 (9)	32 (5)	27 (7)

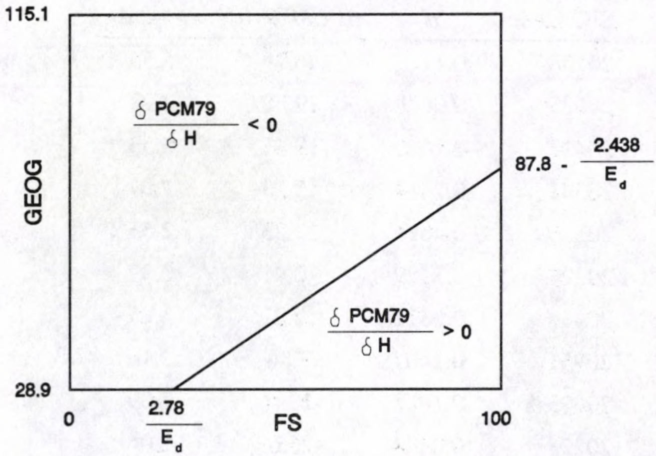
[a] The numbers in parentheses are heteroskedasticity-consistent *t*-values (White (1980))

we obtain

$$GEOG < 0.878\,FS - \frac{2.438}{E_d} \tag{4.3}$$

as the inequality defining the region in (*FS*,*GEOG*) space in which the partial derivative $\partial PCM79/\partial H$ is positive.

Figure 2 The Effect of Concentration on Price-Cost Margins, 1979



It can be seen in Figure 2 that the boundary of this region shifts leftward as E_d increases. For a given level of geographic dispersion, $\partial PCM79/\partial H$ will be positive if a large enough share of shipments goes to food stores. For a given level of shipments to food stores, $\partial PCM79/\partial H$ will be positive if markets are sufficiently regional. These results then suggest that it is in regional geographic markets where final consumer demand is important that increases in market concentration enhance the ability of producers of nationally branded products to extract economic profit.[10]

These results are not without potential policy implications. They suggest that policymakers should be less concerned about mergers that would increase concentration in product lines that are marketed in a national market and as an input to the production of other goods or services, and more concerned about mergers that would increase concentration in product lines that are marketed on a regional basis mainly to final consumer demand.[11]

[10] The boundaries of the regions of statistical significance of the estimated derivative are defined by the equation of rotated conic sections that are symmetric around the $\partial PCM79/\partial H = 0$.

[11] Judgements about particular mergers would, of course, depend on the details of specific cases.

Table 4.2 Statistically significant (at the 5% level) partial effects of changes in concentration, 1979

Obs.	SIC Code	H	$\partial PCM79/\partial H$	t-value
1	20108	0.1129	46.79	5.53
27	20623	0.0678	19.88	4.28
23	20413	0.1626	19.47	5.53
16	20341	0.2814	12.13	2.04
11	20333	0.4634	11.73	2.65
8	20324	0.3129	10.41	2.37
22	20411	0.0871	10.22	4.25
43	20951	0.1407	7.84	2.16
34	20623	0.1412	-20.40	3.09
4	20221	0.0344	-26.69	2.04
32	20451	0.1412	-29.80	2.63
6	20231	0.0543	-33.72	2.76
3	20210	0.0377	-41.26	2.87
30	20430	0.2058	-45.76	2.99
31	20440	0.0795	-56.15	3.35
19	20354	0.0799	-56.20	3.14
39	20871	0.0407	-142.73	3.30

Finally, Table 4.2 reports the statistically significant estimated values of $\partial PCM79/\partial H$ among the 36 observations used to estimate *PCM79*. It will be seen that $\partial PCM79/\partial H$ is significantly positive in 8 cases, significantly negative in 9 cases, and not significantly different from zero in the remaining 19 cases. Concentration levels are higher, on average, for observations that have a significantly positive derivative than for observations that have a significantly negative derivative.

Although the number of significant values of each sign is essentially the same, negative coefficients tend to be larger in magnitude. This explains the negative value at the sample mean.

5. FINAL REMARKS

A quarter of a century ago, Leonard Weiss (1971, p.398) wrote that "Perhaps the right next step is back to the industry study, but this time with regression in hand." The data set built by Connor and Peterson is an example of the kind of work that must be done to carry out Weiss' right next step.

We hope that our methodological comments - on the desirability of controlling for limitations in data quality and the interpretation of results obtained using nonlinear specifications - are be useful.

We also submit that the results yielded here by the Connor-Peterson sample are of interest for policymakers. Market concentration is not a sufficient statistic of the nature of market performance. The concentration-performance relation is conditioned on the interaction of concentration with other aspects of firm conduct and market performance. With appropriate data and estimation techniques it is possible to disentangle some of these interactions.

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